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ABSTRACT

The Yudofsky scale is considered to be one of the best scales for measuring aggressive behavior developed to date. One of the chief shortcomings of the scale, however, is appropriate methods for scoring it in ways that make the resulting scores well-suited for data analyses. The basic scoring problem with the Yudofsky scale is that the scale is inherently discontinuous and non-linear; more specifically, it is a logical rather than classical psychometric scale. A variety of alternative scoring procedures are explored and compared empirically for the Yudofsky scale through an assault vignettes validation experiment conducted using a modified version of the scale. A simple approximation to C. E. Zeeman's swallowtail catastrophe theory model proved to be the best of all the procedures examined. The swallowtail scoring model produced Yudofsky scale scores that discriminated out control (verbal aggression only) from mild and severe assault vignettes with ratio level mean differences between the three vignette types as one would predict for these vignettes. The swallowtail scores were also logically coherent, directly interpretable, and psychometrically excellent. Catastrophe theory--a theory and mathematics of discontinuous and non-linear phenomena--was used effectively to score discontinuous and non-linear logical scales. Two tables are included, 13 references are attached, and the overt aggression scale is appended. (Author/TJH)

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Some Empirical Results of Using Non-linear Scoring Procedures for Yudofsky's Overt Aggression Scale.

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Abstract

The Yudofsky scale is considered to be one of the best scales for measuring aggressive behavior developed to date. One of the chief shortcomings of the scale, however, is appropriate methods for scoring it in ways that make the resulting scores well-suited for data analyses. The basic scoring problem with the Yudofsky scale is that the scale is inherently discontinuous and non-linear; namely, it is a logical rather than "classical psychometric" scale.

A variety of alternative scoring procedures were explored and compared empirically for the Yudofsky scale through an assault vignetttes validation experiment conducted using a modified version of the scale. A simple approximation to Zeeman's swallowtail catastrophe theory model proved to be the best of all of the procedures examined.

The swallowtail scoring model produced Yudofsky scale scores that discriminated out control (verbal aggression only) from mild and severe assault vignettes with ratio level mean differences between the three vignette types as one would predict for these vignettes. The swallowtail scores were also logically coherent, directly interpretable, and psychometrically excellent.

Catastrophe theory (Zeeman, 1976) is a theory and mathematics of discontinuous and non-linear phenomena. Using catastrophe theory models as a guide, procedures for scoring discontinuous and non-linear logical scales are shown not to be the problem or conundrum that they are made out to be in the psychometric literature. The implications of catastrophe theory and the findings of this study for measurement, research, and psychology are discussed.

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Yudofsky (Yudofsky et al., 1986) has developed and reported findings on an Overt Aggression Scale (OAS) that are both intriguing and highly promising. The Yudofsky Scale is divided into four generic categories (verbal aggression and aggression against self, objects and others) that form steps on a general continuum from mild to severe aggression. Each category on the scale has 4 or 5 observable behavioral statements for rating as present or absent, with the items in the category arranged in terms of increasing levels of severity. The conceptualization of the scale (both the categories and items within each category) is extremely good, and derived from reviews of the theoretical, clinical, and experimental literature. The scale is considered to be one of the best scale for measuring aggressive behavior developed to date (Lanza, 1988).

One of the chief advantages of the OAS scale is that it is easy to use as compared to the alternative assessment procedures, particularly in clinic situations, and it is very easy to train people to use the scale and use it reliably. Yudofsky (Yudofsky et al., 1986) reports extremely good test-retest (r=+.87) and inter-rater (r=+.75) reliability for the OAS, and Silver and Yudofsky (1987) report a wide variety of empirical evidence that showed the OAS's great superiority over other procedures (e.g., hospital charts, logs, written reports, observation charts, ward communication books, and incident reports) for measuring overt aggression, and the empirical analysis of the resulting data for trends and intervention effects.

Statement of the Problem

Although one of the attractive and outstanding features of the OAS is its simplicity and ease of use, one of the chief impediments and shortcoming of the scale, in terms of actually using it, is appropriate methods for scoring the scale in ways that make the resulting scores well-suited for refined, unequivocable, and unproblematic data analyses. This fact or problem is not atypical or uncommon with scales such as the OAS, given their discontinuous and "qualitative" character as opposed to the continuous and incremental equal-unit characteristics of "traditional" or classically constructed psychometric scales. Nor is this problem unrecognized by Yudofsky who has tried several different scoring procedures for his scale (Silver and Yudofsky, 1987), all of which had a number of problems relative to generating directly interpretable and meaningful total scale scores that could be simply, easily and directly analyzed.

The basic scoring problem with the Yudofsky scale is that the Yudofsky scale is inherently discontinuous and non-linear. Such discontinous and non-linear scales, phenomena, and problems are characterized by modern theorists as being mathematical "catastrophes," as they make the general linear models that classical psychometric theory are based on malfunction and behave illogically and bizarrely. This basic fact, as well as several alternative models and views to the classical psychometric model, have been formalized by Zeeman (1976) as Catastrophe Theory, which is essentially a branch of mathematics that deals with describing,

representing, predicting, modeling, and explaining non-linear and discontinuous phenomena.

Catastrophe Theory

Catastrophe theory (Zeeman, 1976) is the general mathematics of combining multiple logical criteria (or dimensions) and the "state" values of each criteria into a "folded plane" or surface that precisely describes the unique ordered set of points for all logically permissible states and state combinations; namely, a "scalar continuum" of a particular kind. The reason that the Yudofsky scale is a mathematical "catastrophe" is that the scale is first and foremost a logical and conceptual "scale," or serial set of "states" and permissible state combinations, rather than a unidimensional, equal-unit continuum, or progression, or serial progression from one to another along a number line.

Catastrophe theory provides the "mathematics" and the "mechanics" for consistently and coherently implementing at the operational level as unique "surface points" rather than as the same "surface point," the logical proposition that "if someone is an X, then they cannot be a Y, and if someone is a Y, then they cannot be an X, given that the total item score value of X and Y generated from items on the scale is the same." Catastrophe theory can handle nested logical criteria and even logical criteria that are contradictory. In a word, catastrophe theory is the mathematics and mechanics of scoring "logical scales" logically, and not "numerically" or "psychometrically." Another way of stating this point is that logical scales are matrices of states

and not "natural scalars." Catastrophe theory is the mathematics and mechanics of transforming (mapping) logical matrices or states and their combinations onto a scalar continuum.

What makes catastrophe theory so unique and powerful is that it can handle logically contradictory criteria or dimensions with equal ease and facility as logically consistent or uniform criteria, and it is this feature of catastrophe theory that makes it so interesting, and interesting in terms of the uniquely different surfaces and models that it generates depending upon the number and logical type of the input criteria. It is also this feature of catastrophe theory that makes it so powerful and capable of modeling with great precision such contradictory, discontinuous, and non-linear phenomena as aggression, anorexia nervosa, the stock market, cathartic release from self-pity, the buckling of an elastic beam, phase transitions, and a wide variety of other such non-linear phenomena.

Zeeman (1976) has identified 7 different catastrophe theory models. The exact "folded plane" or surface of each model is a function of the number and type of logical criteria operating in a given context. Each model is well-known and well specified empirically, and each catastrophe model has its own unque polynomial regression equation and standardized weights. These catastrophe theory models and their polynomial regression equations and weights may be used as guides for scoring the Yudofsky scale, which is essentially, in its nature and character, a prime example of a discontinuous, non-linear phenomenon. A very detailed analysis and explanation of catastrophe theory is given by Zeeman

(1976), and a detailed analysis and model for scaling data sets that are matrices of logical categories and their permissible combinations is given by Carifio (1975).

The basic characteristics of the Yudofsky scale, and the associated problems that come with these characteristics, is a very general basic scoring problem currently being faced by a broad array of researchers in many different areas who construct and utilize such scales. Such scales, moreover, are being constructed and utilized now with a far greater frequency than in the past due to a greater emphasis on construct validity in terms of appropriate and sound conceptualization of the phenomena being measured. Given these facts, simple, easily implementable, effective, and successful scoring procedures for logical/conceptual scale are a great outstanding need, as such scales typically tend to have outstanding construct validity.

METHODOLOGY

We were drawn to the OAS through experiments we were conducting with written vignettes that described aggression against nurses by patients, where the aggression ranged from verbal abuse only (the control or placebo vignette) to mild and severe physical assault. The sex of the nurses were varied in these vignettes (male and female), but the sex of the patient was always male to keep the experimental design simple initially.

Basically, the vignettes that were to be used in our studies described a somewhat casual conversation between a nurse (female or male) and a patient (male) who occasionally hit people about the

patient's weekend pass. The patient inadvertently tells the nurse that he is going home on a two day weekend pass. It is the nurse's understanding, however, that a one day pass has been approved for the patient by his treatment team, and when this fact is related to the patient, the patient becomes hostile and verbally aggressive towards the nurse. The nurse then tries to calm the patient down by suggesting that they discuss the matter.

The three different treatment conditions that were going to be examined in our studies varied in terms of the ending used to this vignette; namely, in terms of what happened from this point forward in the vignette.

In the Control (verbal aggression only) vignette the patient tell the nurse aggressively what the nurse "can do" and where the nurse "can go," and then abruptly turns and walks away, ending the vignette.

In the Mild Assault vignette, the patient aggressively tells the nurse what the nurse "can do" and where the nurse "can go," and then grabs the nurse very hard by the wrist and will not let go. The nurse needs help to get free from the patient and the nurse's wrist has a reddened mark on it after the incident is all over, which is the end of the vignette.

In the Severe Assault condition, the patient aggressively tells the nurse what the nurse "can do" and where the nurse "can go," and then grabs the nurse very hard by the wrist and and starts punching the nurse on the arm. The nurse loses her or his balance, falls, and hits her or his head against the wall. When help arrives, the nurse is bleeding from several head cuts and has a severely

sprained arm and wrist, which is the end of the vignette.

After reading each of the above vignettes, a subject would answer 13 questions, using a five point rating scale, which assessed the degree to which the nurse professional was responsible (to blame) for the incident that occurred. These 13 items, which were exactly the same for all vignettes, were found to to be excellent psychometrically (see Carifio and Lanza, 1989 for details). The Cronbach internal consistency coefficient for these 13 items was r=+.91 (N=64), and the one week test-retest reliability coefficent was r+.86 (N=55). These reliability coefficients were the same across all forms of the vignettes used and were not different from those observed by Lanza (1987).

One of the fundamental problems that we faced in using the vignettes we devised for our experiments was empirically validating each vignette as being a control, mild, or severe assault vignette. To establish the external, objective, or content validity of our 2 control vignette and 4 assault vignettes, we used a panel of 12 professional experts and a modified version of the Yudofsky OAS for the experts to rate the degree to which specific characteristics were present or absent in each of the 6 vignettes. We presented all vignettes to each rater in a different random order. The raters completed the modified Yudofsky scale for a vignette before responding to the next vignette in her or his package.

Our working hypothesis was that the Yudofsky scale scores should discriminate out the three types of vignettes we had and place them on a continuum with some type of appropriate ratio metric and that no differences should be found between female and

male nurse vignette of a given type (control, mild, or severe). Our validity study, therefore, was as much on or about the Yudosky Scale and its characteristics and performance as the vignettes. The modifications made to the Yudofsky scale were (1) only 2 of Yudofsky"s 4 overt aggression categories were used (verbal aggression and physical aggression towards others), and (2) a global summative judgement item was added to allow the rater to classify the vignette overall as being a vignette that portrayed verbal aggression or mild or severe assault (see attachments for details). The panel of expert raters were 3 physicans, 2 psychologists, and 1 social worker, all of whom were male, and 5 nurses, 4 of whom were female and 1 of whom was male. The average age of the raters was 43 years, and the average number of years of hospital work experience was 16 years. Nine (9) of the 12 raters had experienced mild assault on the job, and 2 had experienced severe assault. One of the male raters who did not use the scale properly was dropped from the item-level analyses conducted.

Scoring Procedures

In terms of the 9 items and 2 categories of the modified Yudofsky scale we used, a variety of weighted scoring procedures using classical psychometric theory (Kurlinger, 1978) and Catastrophe Theory (Zeeman, 1976) were tried and compared empircally in terms of their performance. Simple and weighted sums, and other scoring procedures from classical psychometric theory produced a variety of problems, both logically and otherwise, of the kind described by Silver and Yudofsky (1987) and

Zeeman (1976). Logical scoring procedures (Carifio, 1975) performed better than classical scoring procedures, but the scoring procedures based on catastrophe theory performed best of all.

The best procedure of the many procedures examined turned out to be a simple approximation of Zeeman's swallowtail model, which generates converging parabolas whose terminal points represent logical conditions which are mapped to mathematical values (i.e., scale points). The reason that this simple approximation procedure turned out to be best will be explained later in this paper.

The simple swallowtail approximation scoring procedure we developed, which was used in the analyses reported below, was as follows: as the 9 items of the modified Yudofsky scale were arranged in order of increasing aggressive behaviors, we successively added one additional scoring point to each item to give the item a weight that reflected the increasing severity in aggressive behavior that it respresented as one progressed up the scale. A simple plotting of total score results for this procedure against the scale items checked (responded as present by a subject) will quickly show the roughly S-shaped parabola generated by this scoring procedure, a curve which both describes and precisely characterizes probablistically bimodal logical states linked directly to total scale scores. It should be noted that the resulting scale scores can be easily linearized and intervalized by a variety of existing procedures (see Coombs, 1964), if one so desired, or the demands of analysis imposed such a requirement. In a word, this problem is not a problem.

We also used this weighted "swallowtail" scoring procedure to

derive total subscale scores both within and between the two categories (i.e., verbal aggression and physical aggression) of the scale so that each category could be examined both individually and comparatively. It should also be noted that there are a number of simple variations of our approximation to the swallowtail procedure that can be employed in various situations. For example, a factor of 10 may be added to the total score for each category on a multiple category scale. This procedure will order the logical categories into distinct regions (scale areas) and provide refined scores within regions and interpretable individual scores and means. The reason why these simple approximation procedures are sufficient and work so well will be explained later in this paper.

Results

In terms of the global vignette type classification measure added to the Yudofsky scale, 100% of the 12 raters accurately identified both of the control vignetttes as verbal aggession only and both of the mild assault vignettes as mild assault. Only 9 of 12 (67%) of the raters, however, correctly identified the severe assault vignettes as severe. The three raters who misclassified the severe assault vignettes were very "assault experienced" raters and made up their own category of "moderately severe" for these vignettes which they wrote on the rating scale and checked. This finding is not only somewhat startling, given the vignettes described above, but says more, we believe, about the level of severity of assaults that occur in hospitals and the degree to which professionals become inured to them, than the actual

characteristics of the severe assault vignettes.

The inter-rater reliability coefficient for the global classification of the vignettes was r=+.94, and, in general, all 12 of the raters found all of the vignettes to be plausible on the 6 factors rated. At the global level, therefore, the evidence for the objective validity of the vignettes constructed was very good.

In terms of the 11 raters retained for analyses, their internal consistency in ratings across the 9 items was r=+.56. This internal consistency coefficient, which is reasonable for 9 scale items of this type and mixture, was established by conducting a Severity of Incident with the Patient by Sex of the Nurse Practitioner (3x2) Hoyt repeated measures analysis of variance as described in Kerlinger (1986) using the presence or absence of a response for each scale item as the dependent (repeated measures) variables.

Table 1 presents the results of a Severity of the Incident with the Patient by Sex of the Nurse Professional in the Vignette (3x2) repeated measures ANOVA for the Total Severity of Aggression in the Vignette weighted score derived for 11 of the 12 raters in this vignette validation study. As can be seen from Table 1, a highly significant main effect difference in total severity of aggression in the vignette was observed between the control, mild and severe vignettes, with roughly <u>ratio</u> level differences between the means of each vignette type, which should be present if each vignette type represents a truly different level of severity in aggressive behaviors. No significant differences were found relative to the sex of the nurse professional in the vignette

Table 1: SEVERITY OF INCIDENT WITH PATIENT BY SEX OF THE NURSE PROFESSIONAL INVOLVED (3X2) REPEATED MEASURES ANOVA ON TOTAL SEVERITY OF AGGRESSION IN THE VIGNETTE WEIGHTED SCORES (N=11).

Severity of Incident

Sex of Nurse Prof.	(Verbal Abuse) Control N	Mean	St.D.	Mild Assault N	Mean	St.D.	Severe Assault N	Mean	St.D.
Female Nurse	11	3.5	1.9	11	8.5	3.7	11	14.2	6.0
Male Nurse	11	3.3	1.8	11	9.0	4.2	11	15.3	6.7
Total	11	3.4	1.8	11	8.7	3.9	11	14.7	6.4

Source	df	Mean Sq.	F	p
Subjects	10	40.91		
Sev. of Incident(SI)	2	710.97	23.17	<.0001*
Error	20	30.68		
Sex of Nurse (Sex)	1	3.88	1.18	>.05
Error	10	3.28		
SI x Sex	2	2.24	0.35	>.05
Error	20	6.39		
Total	65			

or significant interaction. Raters found no differences in the total severity of aggresion present in a given vignette in terms of the nurse practitioner in the vignette being male or female.

A clearer understanding of these results presented above may be obtained by examining the degree of physical assault present in the vignette weighted subscale score that was devised. Table 2 presents the results of a Severity of the Incident with the Patient by Sex of the Nurse Professional in the Vignette (3x2) repeated measures ANOVA for the Degree of Physical Assault Present in the Vignette weighted subscale score for 11 of the 12 raters in this vignette validation study. As can be seen from Table 2, a highly significant main effect difference in total severity of aggression in the vignette was observed between the control, mild and severe vignettes, with greater than ratio level differences between the means of each vingette type, which should be present if each vignette type represents a truly different level of severity in aggressive behaviors. No significant differences were found relative to the sex of the nurse professional in the vignette or significant interaction. Further, as can be seen from Table 2, no phsyical assault was found in either of the control vignettes by any of the 11 raters using the Yudosky scale.

From the results presented above, it would seem reasonable to say that the item-level evidence for the objective and content validity of the 6 vignettes constructed is more than relatively good, as is the evidence for the effectiveness and success of the

Table 2: SEVERITY OF INCIDENT WITH PATIENT BY SEX OF THE NURSE PROFESSIONAL INVOLVED (3X2) REPEATED MEASURES ANOVA ON DEGREE OF PHYSICAL ASSAULT PRESENT IN THE VIGNETTE WEIGHTED SUBSCALE SCORES (N=11).

Severity of Incident

Sex of Nurse Prof.	(Verbal Abuse) Control N	Mean	St.D.	Mild Assault N	Mean	St.D.	Severe Assault N	Mean	St.D.
Female Nurse	11	0.0	0.0	11	1.4	0.9	11	3.3	1.6
Male Nurse	11	0.0	0.0	11	1.4	0.9	11	3.1	1.4
Total	11	0.0	0.0	11	1.4	0.9	11	3.2	1.5

Source	df	Mean Sq.	F	p
Subjects	10	2.05		
Sev. of Incident(SI)	2	56.06	28.12	<.0001*
Error	20	1.99		
Sex of Nurse (Sex)	1	0.61	1.00	>.05
Error	10	0.61		
SI x Sex	2	0.61	1.00	>.05
Error	20	0.61		
Total	65			

simple approximation to the swallowtail scoring procedure used for the Yudofsky scale. The simple approximation to the swallowtail model produced Yudofsky scale scores that were logically coherent and behaved as predicted. The swallowtail scores were directly and easily interpretable and psychometrically excellent.

DISCUSSION

Using the modified Yudofsky scale, subjects could objectively and reliably discriminate out levels of aggressive behaviors and assault and non-assault behaviors in the vignettes, with ratio level differences between the means of each vignette type, which confirmed our working hypothesis and was not observed with any of the other scoring procedures tried. The ability of subjects to make these kinds of discriminations and to make them reliably has been a major and outstanding unanswered question in the literature in this area. It should be noted, however, this question would not have been answered as well or as convincingly as it is in this study if we had not used control vignetttes, which is an important point experimentally. Consequently, the results reported here not only support and add to the validity evidence for the Yudofsky scale, but they also support a better way to score this scale and scales like it, which will improve data quality and resulting analyses from such scales.

Catastrophe theory and theories similar to it, such as Chaos theory (Gleik, 1987) and other such non-linear theories, have a great deal to offer measurement, research, and psychology in a wide

variety of ways other than just providing procedures for scoring discontinuous and non-linear logical scales (Cronbach, 1988). These theories and their associated models are extremely powerful relative to modeling, thinking about, and dealing with broad areas of phenomena in measurement, research and psychology, and psychological processes and behaviors. For example, the simple scale scoring procedures derived from these theories and reported in this paper can be used to model, quantify, and score scales that measures stages of development such as Piaget's, Kohlberg's, or Erickson's. These theories and their associated procedures, however, are not well-known or common knowledge in these areas of measurement, research or psychology.

One problem that we believe has worked against these theories and models being explored and utilized by researchers is their logical and mathematical complexity and sophistication. They are not easy theories or models to work with until one gets a lot of prctice utilizing them. It was for this reason that we purposely sought to devise and explore a scoring procedure that was a simple and easily implementable approximation of the swallowtail catastrophe model so that active researchers would have simple and easy to implement procedures for employing this model in the conduct of their research activities. There is, however, also another reason why we sought to achieve this particular goal.

A great deal of indirect and informal evidence tends to suggest strongly that catastrophe theory, chaos theory, and theories similar to them may be, in specific instances or implementations, NP-Complete problems (Cook, 1971). NP-Complete

problems are problems that are computationally intractable and thus unsolvable algorithmically or mathematically. There are a wide variety of vexing, important, and practical problems such as scheduling that are now known to be NP-Complete problems, and every area and every discipline has its "fair share" of such problems. Graham (1978), however, found that any NP-Complete problem could be "solved" and "solved well" by simple approximation procedures that were relatively easy to use and implement, which achieved as close to "perfect results" as could be theoretically obtained for the problem. It is for this reason that we focused from the outset on exploring simple catastrophe theory approximation scoring procedures for researchers to use rather than using catastrophe theory's complex weighted polynomial regression equations for each of the known catastrophe theory models to score the Yudofsky scale. Quite simply, we believed that it was the wisest path to follow to solve the problem and produce usable results and procedures that other researchers could always and reliably use.

Given all of the above points we have made, we believe that the construction, use, and scoring of discontinuous and non-linear logical scales should not be seen by researchers as being a major or highly messy and unsolvable problem that requires that old "psychometric" models be adopted so that one can proceed with one's research. There are relatively simple answers for discontinuous and non-linear logical scales that can be easily employed and should be employed, because appropriate conceptualization and construct validity is everything, and should only be sacrificed very, very, grudgingly.

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